# Retrievals of Peroxy-Acetyl Nitrate (PAN) from the Tropospheric Emission Spectrometer

V. H. Payne[1], M. J. Alvarado[2], K. E. Cady-Pereira[2], J. R. Worden[1] and S. S. Kulawik[1]
[1]Jet Propulsion Laboratory, California Institute of Technology
[2]Atmospheric and Environmental Research (AER)

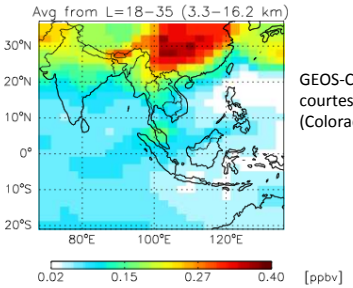
## Introduction

Peroxy Acetyl Nitrate (PAN) is a thermally unstable reservoir for NOx that can be transported over large distances before converting back into NOx, thereby altering ozone formation far downwind from the original source. Satellite retrievals of PAN could potentially provide substantial information on the fate of NOx emissions from a range of sources including biomass burning and motor vehicles and the impact of these NOx emissions on global tropospheric ozone. PAN is currently poorly represented in global chemical transport models (CTMs), as indicated by a failure to reproduce many of the existing ground-based and aircraft observations.

PAN has previously been retrieved in the upper troposphere and lower stratosphere from limb observations on a global scale from Envisat-MIPAS [Moore et al., 2010; Wiegele et al., 2012] and in biomass burning plumes from ACE-FTS [Coheur et al., 2007]. PAN signatures have also been observed in nadir observations of smoke plumes from fires by both the Aura TES [Alvarado et al., 2011] and MetOp-A IASI instruments, but to our knowledge, PAN has not yet been retrieved in the nadir view on a global scale. Here we present initial work on developing a global PAN retrieval from TES measurements.

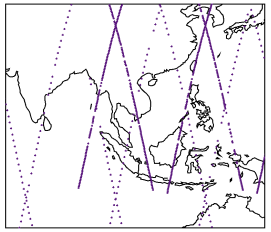
## PAN over Asia

GEOS-Chem PAN for 20080802



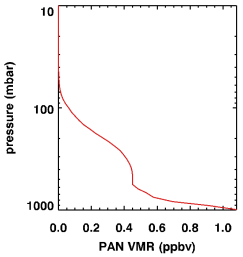

GEOS-Chem results courtesy of Daven Henze (Colorado State)

TES measurements for 20080802

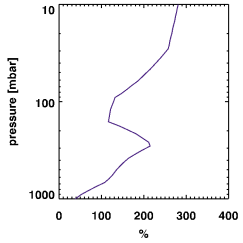


TES coverage for this day includes global surveys and step and stare special observations

## "Polluted" PAN profile

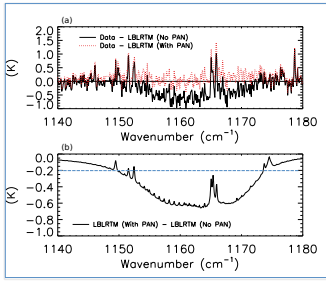



## A priori variance




Diagonal of the a priori constraint matrix. Variance was calculated from GEOS-Chem output over Asia in August.

## Expected signal to noise and interferents




**Previous observation in boreal fire plume**

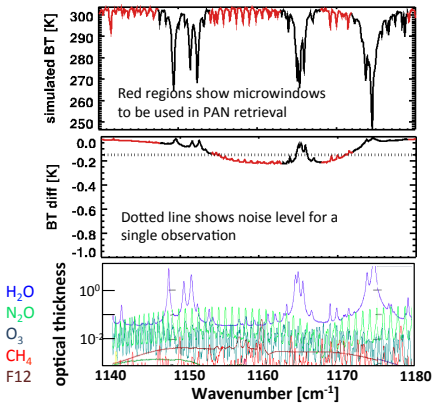
Alvarado et al. [2011] had previously observed PAN in a TES measurement that sampled fresh smoke from a Canadian fire. Residuals were fitted using a profile with peak PAN concentration of **1.9 ppbv** at **560 hPa**. PAN associated with pollution from cities would be expected to show a different vertical distribution, with peak values at the surface.

**Simulations over Asia**

Simulated spectrum, using "polluted" PAN profile. (Peak PAN concentration is **~1 ppbv** at **surface**.)

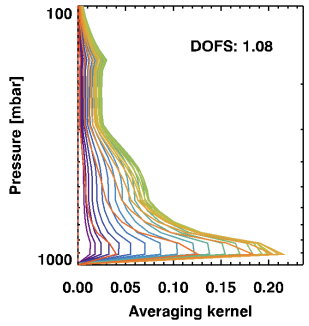
Difference between simulation with and without PAN

Interfering species




Interfering species optical thicknesses from http://www.atm.ox.ac.uk/group/mipas/atlas

## PAN Averaging Kernel




## Summary/ Future challenges

- With further work, TES observations can be used to provide information on spatial variation of PAN in the free troposphere.
- Expect ~1 DOFS for observations of **highly elevated** PAN.
- Cases where signal-to-noise > 1 are likely to be few and far between.
- Aggregation of multiple observations could allow improved signal to noise, at the expense of spatial/temporal resoultion.

**Future work:**

- Retrievals from real data.
- Retrievals on global scale.
- Validation.

## References


- Alvarado et al.,(2011), Atmosphere [2011], 2, 633-654, doi:10.3390/atmos2040633
- Clarisse et al.,(2011), GRL, 38,10802, doi: 10.1029/2011GL047271
- Coheur et al.,( 2007), Atmos. Chem. Phys., 7, 5437–5446
- Moore and Remedios (2010), Atmos. Chem. Phys., 10, 6117-6128 Wiegele et al. (2012), Atmos. Meas. Tech., 5, 723-734
- http://www.atm.ox.ac.uk/group/mipas/atlas